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ABSTRACT

This paper is concerned with the kind of messages about science conveyed to 23 young gifted children enrolled at the McGill Summer School for Gifted and Talented Children in Montreal while utilizing a particular teaching model. Five science lessons were analyzed by applying a newly developed scheme to classroom interactions. The scheme helps to identify three views of science, i.e., the two polar views of sensationalism and formalism, and a rational, balanced via media view. The pedagogy in this gifted class involved the application of the Calvin Taylor Multiple Talent Approach--a teaching model which focuses on developing six talent areas to enhance the inquiry skills of gifted/talented students. The talent areas include creativity and decision-making talents, planning and forecasting talents, communication talent, and thinking ability. Recognizing that gifted children have more general knowledge and varied experiences than students not so identified, it was hypothesized that applying the Taylor model would facilitate children's acquisition of a via media view of science; this was not borne out. Analysis revealed that only two of the six inquiry skills were being developed during lessons, and in such a way as to convey a sensationalist view of science more often than a via media view. These results have important implications in developing science curricula for and teaching science to gifted children. (JN)

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TEACHING SCIENCE TO GIFTED CHILDREN: THE MODEL AND THE MESSAGE

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Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, French Lick Springs, Indiana, April 1985.

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Teaching Science to Gifted Children: The Model and the Message*

This paper is about teaching science to a group of very young gifted children. Specifically, the purposes of the study from which this paper is drawn, were twofold The first was to characterize the conceptions or ideas about scientific inquiry which were conveyed to the children during five ordinary science lessons. The ideas about science were identified by analyzing classroom interactions and by application of a previously developed analytical scheme (Wolfe, 1982). The second purpose was to examine how a particular teaching model, the Calvin Taylor Multiple Talent Approach, impacts on the children's acquisition of the ideas.

Background

Teachers, as a result of various influences, come to the classroom with a personal philosophy of teaching and learning. Formative experience, including teacher education, have helped them acquire certain ideas and beliefs about science. In the classroom, provision is made for pupils to become aware of these selected ideas by the very manner in which teachers organize the science lessons--the classroom activities and the teacher-pupil dialogue. As a consequence, teachers often convey misunderstandings and confusions without being fully aware of doing so. Butts (1984) examined various approaches to research in science education and speaks to the very issue of what occurs

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in the classroom and how conceptions are conveyed by teachers and assimilated by pupils.

> If teachers influence what students learn by controlling what, and how, and how long the student studies science, then it is this link between teacher behavior and student classroom behavior that is a significant area of needed study. (Butts, 1984, p. 551)

A far reaching report on the state of science education in Canada was sponsored by the Science Council of Canada (1984). In the introduction to one of the volumes, the authors confirm that science teachers play a "central role in determining what can and does happen in the classroom" (Olson and Russell, 1984, p. 13). Moreover, the teachers' influence is conveyed through the thoughts and beliefs they bring to organizing and presenting their lessons.

Recent research in science teaching reveals the numerous attempts by investigators to systematically observe classroom interactions in order to examine the influence of the teaching process. For example, Smith and Anderson (1984) find that elementary school children hold interpretations about photosynthesis which differed from that which the teacher was attempting to convey. Hertz-Lazarowitz et al. (1984) tabulate Junior High School students' behavior under various modes of instruction. Studies such as these, however, do not consider the substantive issue of the <u>kind</u> of messages about science children receive during lessons. Moreover, the literature on gifted children supports the view that classroom interactions reveal

important information about the pupils' perceptions of themselves, of others, of school, as well as of their learning. However, such studies (for example: Maltby, 1984; Griggs and Dunn, 1984) do not examine the conceptions about science (or about other subjects for that matter) acquired by gifted pupils during lessons.

The need to identify what ideas and beliefs are being conveyed during science lessons was the impetus for an extensive research study which resulted in the development of a 9-category analytical scheme for analyzing classroom interactions (Wolfe, 1982). The clues of the scheme enable a practitioner to differentiate between three different views of scientific inquiry which are transmitted during lessons; the clues also reveal the activities or processes by which the pupils become so aware (Figures 1, 2, 3).* In the present study this scheme is used to analyze the lesson interactions with gifted children--in order to identify which of these ideas about science are being conveyed to this particular group of pupils.

Discussion of the study continues as follows: First, there is a brief identification of giftedness and a review of the inquiry skills stressed by application of the Calvin Taylor model used for teaching gifted children. This is followed by a description of the messages about science which are characterized in the analytical scheme used in the study. The context and procedure of the study is then described. Finally, the results are discussed by referring to extracts from science lessons. In

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*See Appendix. Derivation of the categories and clues of the scheme is fully explained in Wolfe, 1982.

conclusion, the results are related to teaching science in classes for gifted children.

Giftedness and a Teaching Model

Intellectually gifted children are recognized as having the ability to solve problems effectively, to think divergently and to conceptualize skillfully. Moreover, through a variety of experiences, they accumulate more information more quickly than do most other children, and they retain what they learn with a minimum of practice. Gifted children are spontaneous and original during lesson interactions and they pose endless questions in their search for information. Freehill (1982) indicates that such high intellectual behavior is a result, not only of "neural structures", but is stimulated through experiential demands. This, of course, presents a challenge for teachers of the gifted. It is expected that such teachers would understand the cognitive development of gifted and talented children and would be carefully trained to provide rich and stimulating learning environments (Wallace, 1983). Provision of such environments is often fulfilled through the application of a teaching model especially designed for gifted classes. In this study, the Calvin Taylor Multiple Talent Approach is the teaching model used by the "master" teacher (Maker, 1982).

The Calvin Taylor Multiple Talent Approach stresses the acquisition, rather than the use, of knowledge. This is accomplished by the teacher through either open-ended or planned activities which stimulate the development of 6 talents or skills of inquiry. These skills are creative talent, decision-making talent, planning and forecasting talent, and communication

talent. The sixth, thinking abilities, encompasses the other talent areas. A closer examination of these talent/skills reveals the usefulness of this pedagogical model in enhancing scientific inquiry.

Creative talent includes flexibility and originality--the skill to generate new ideas and to solve "problems in new and unusual ways" (Maker, 1982, p. 300). While the teacher might present a problem and permit time for pupils to share and revise their ideas, the pupils' products are interesting and spontaneous. A decision-making talent involves evaluating possible solutions from different points of view and reaching defensible conclusions. The planning talent includes the ability to organize a task with detailed sequences that carry the task to completion. A forecasting talent is the ability to predict future events. The communication talent is the ability to express views descriptively, precisely, in a way that is understood by others. Thinking abilities are needed for decision making and planning as well as in forecasting and communication skills. Thinking ability involves divergent, convergent and evaluative thinking skills.

Since science lessons in classes for gifted children are frequently the vehicle for problem solving and inquiry based experiences, then the kind of ideas about science to which the children are exposed would be conveyed during application of this model and would, over time, be assimilated by the children.

Messages About Science--A Scheme

The scheme used to analyze the science lesson interactions characterizes three philosophical views about science: polar

views of sensationalism and formalism, and a rational via media view. These views are conveyed when one or more clues, associated with each view, are identified in the discourse of a lesson. The clues also reveal the science activity through which each view is conveyed: observation, explanation, and experimentation. A sensationalist view is conveyed when the pupils' investigative curiosity is guided by concrete, sensory experiences. These are considered to be of greater value in understanding scientific events than existing knowledge of the events being observed or discussed. The teacher, then, would eschew provision of science information or direction in science activities. The pupils and the teacher would use simple, descriptive vocabulary to talk about events experienced. A formalist view is identified when the teacher's science knowledge and understanding establishes the "formal" purpose and direction of the class activities. Thus, the pupils' own experiences and perceptions are expected to "fit into" the teacher's preconception--what the teacher believes to be scientifically acceptable. A via media view assumes that both teacher and pupils apply and relate their varied experiences and knowledge to their inquiry in a meaningful way and that they demonstrate a balanced rational approach to problems. Such a view of scientific inquiry is the most difficult to identify in primary classes, because of the restricted scientific understandings of young children. Consequently, the clues associated with the via media view are considered to be forerunners to such a conception of scientific inquiry; and, only the development or the beginning of such a view would be evident among primary school children.

Gifted children, however, do have varied experiences and more knowledge than children not so identified, even though these experiences, inquiry skills and extended knowledge would be more evident in older gifted children. In conveying this view of science, then, the teacher would provide a framework to help pupils relate events observed and discussed and help them recognize certain features as more relevant than others. Pupil activities would be guided by information and experiences. The children's explanations would be rational and their vocabulary would show an understanding of complex terms.

It is not difficult to notice that the talent/skills of the Calvin Taylor teaching model reveal characteristics closely related to those which have been identified with a via media view of science. In carrying out this study, then, it was hypothesized that, because of the particular intellectual skills of gifted children, the lesson interactions would reveal the development of a rational, balanced, via media view of science as characterized in the analytical scheme. It was also hypothesized that application, by the "master" teacher, of the Calvin Taylor model, with its focus on the processes for the acquisition of inquiry skills, would facilitate the transmission of these ideas.

Method

The Context

The population for the study was 23 intellectually gifted children, 7-8 years of age, attending a four-week summer school.* The instructor was a "master" teacher with a Master's degree in teaching the gifted and talented. The science activities involved the development of brine shrimp eggs, with the children observing and discussing the growth, development and "behavioral changes" of the organisms. The daily, one-hour lessons were carried out in two areas. A large classroom was used for full class discussions, while a narrow, windowless cloakroom was used as "the lab" to house numerous small, clear plastic containers of shrimp in brine solutions. It was here that the pupils were brought, in small groups of 6-8 children, to observe and make notes about the organisms.

The children did not experiment with different brine solutions for the shrimp eggs nor did they decide on how much food (yeast) would be added to each container of eggs and organisms. However, there were class discussions prior to adding the eggs to the brine solutions. The teacher carried out all the activities with the organisms.

The children made initial observations of the shrimp by using tiny hand lenses and an overhead projector. They placed

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*The pupils were participating in the McGill Summer School for Gifted and Talented Children. Pupils are drawn from Montreal area schools and the "master" teachers are recruited from Canada and the United States. Apart from providing enrichment activities for the pupils, the school is a training/research centre for graduate students and serves to implement different teaching models.

their containers of brine solution and shrimp eggs on the projector surface and discussed what was seen in the reflection on the wall. For subsequent lessons, this investigator provided a projecting microscope. During the final lessons, the pupils had the use of 6 student-size microscopes with a 750X magnification. The teacher (with the help of the investigator) prepared the slides for viewing in the microscopes. Throughout the school period, the teacher implemented the Calvin Taylor Multiple Talent Approach as the teaching model for all her lessons.

Procedure

Data collection. The main data for the study were derived from the five science lessons. Two lessons were conducted in the classroom and three were held in the converted coat room or "lab". The investigator was a non-participating observer who took extensive notes of all classroom activities. Audio recordings were made of all teacher-pupil and pupil-pupil discourse. At the end of the summer school period, the teacher was interviewed, as were 8 children. The interviews were also recorded. All recordings were then transcribed verbatim.

Data analysis. The classroom interactions were analyzed by a careful application of the analytical scheme to the discourse and activities. This was accomplished by searching the discourse for substantive clues which characterize one (or more) of the views about science identified by the scheme (Figures 1, 2, and 3). A view was not identified by a single comment or episode in a lesson. Rather, the repetition of clues in many episodes revealed a pattern of behavior and it is this pattern which

determined whether or not a particular message about science was being conveyed by the teacher or was being acquired by the pupils.

The interview with the teacher was analyzed to determine whether or not the teacher had come to the lessons with a particular view of scientific inquiry and what that view was. This information would clarify the evidence revealed by the messages conveyed in the lesson discourse. The interview also provided further evidence about the teaching model--the usefulness of the model in carrying out the science lessons. The children were interviewed to find out something about their personal knowledge and interest in science.

Discussion of Results

Analysis of the lesson interactions and application of the scheme reveal that more than a single view or message about science is being transmitted to the pupils. A sensationalist idea is the predominant view identified through the observational activities of the pupils and through explanations. There is, however, some evidence of the beginning of a via media view, also through observation and explanation, and most often this is revealed by the children's comments during the classroom discussions. The lesson interactions also reveal that the communication skill of the teaching model is stressed with brief evidence of thinking and decision-making skills, but few opportunities are provided for pupils to develop or apply the other elements of the model such as the forecasting or the planning skills. Thus, the manner in which the Taylor model is applied appears to support and convey the sensationalist view,

rather than the beginning of a via media view, about scientific inquiry.

Brief extracts from the discourse of the science lessons are presented below. These extracts, with accompanying discussion, illustrate how repetition of the clues serves as evidence that a particular view about science is being conveyed. The inquiry skills, characteristic of the teaching model, are also identified in the extracts. Then, the interviews are discussed as these relate to the messages conveyed in the lessons.

"Lab" Lessons

The first lesson was carried out in the "lab" with small groups of 6-8 children. The pupils were expected to observe the shrimp eggs and detect, as much as possible, changes which had occurred. The observations were made using an overhead projector and small hand lenses.

A sensationalist view about science dominates the discourse and is revealed by the manner in which the teacher solicits and accepts the pupils' observations. She does not provide science information about the shrimp to help the pupils make sense out of her questions or their own perceptions.

T: What do you see, Makeba? Do you see any changes from yesterday, at all?

Makeba: The dots are bigger.

T: You think the dots are bigger? All right. I want you to take a look with your glass (hand lens) and see if you see anything.

Makeba: No, not at all. Very little.

T: All right. Will you mark that down in your notes, Makeba.

The same clue is repeated in another episode.

P: Hey, one of the seeds, one of the eggs here are big.

T: Well, mark that down, that it appears one of the eggs has gotten bigger. That it appears, huh?

P: And the eggs are getting separated as though they were all hatched up.

T: The eggs are separating. All right.

P: Yeah, and they're falling to the bottom.

T: Mark that down.

Here was an opportunity for the teacher to clarify the pupils' perceptions about "hatching". If the teacher had explained the difference between hatching (of chicken eggs, as the children understand the term) and the development of the shrimp eggs, she would have conveyed the beginning of a via media view about science (relating science information with pupils' understanding and experience). Rather, the pupils are only expected to talk about and record their perceptions. Later in the lesson, a pupil asks, "Do brine shrimp eat anything?" The teacher responds, "That we don't know". She then proceeds to inquire about new observations. The teacher, then, continues to avoid responding to questions. This could leave the pupils with the impression that further observations are needed to understand what is perceived. A clear sensationalist message.

The extracts also reveal that the communication skill of the Calvin Taylor model dominates the interactions. This is evident by the teacher's expectation that the pupils talk about and describe their observations.

For subsequent lessons the pupils' observations were greatly enhanced by a projecting microscope. The instrument afforded a

clear view of the body structures of the shrimp, their legs and antennae, and coloured food (yeast) could be observed passing through the digestive tract.

Again, the prevailing idea about science being conveyed is sensationalism. Standing around the microscope the children are asked to describe what they see. The new observations provoke questions to which the teacher does not respond, even though these require information that cannot be acquired by the pupils' random observation.

P1: How come that one's different than the little one?

T: How do you see it different?

P1: Well, he's bigger. He has more legs. This one only has two.

P2: How come? Is that one a full grown shrimp?

T: It's not fully grown. But what do you think?

P1: It's a yearling.

P2: Well, that one got hatched before the other one.

T: Uh huh. What's happened to the little one?

The extract is an example of the children's communication skills and the creative use of language. It is good pedagogical strategy to turn the pupil's question back to the child ("But what do you think?") and thus an effective use of the teaching model. From the point of view of science inquiry, the teaching behaviour conveys a sensationalist message since the pupils' random comments are accepted as given and are not discussed further. The teacher might have helped the pupils relate what they see with their own understanding about the growth of other, similar organisms. That strategy would have helped develop the

decision-making skill (of the model) at the same time as conveying the beginning of a via media view about science inquiry.

The following extract illustrates a repetition of the same behaviour.

T: He's eating something, obviously. Can you see what he's eating?

P1: Yeast.

T: How do you know he's eating?

P1: 'cause--his antennas are going out and grabbing the food.

P2: Yeah, it's really very fast.

T: Do you think antennas would be used for grabbing food?

P1: Yes.

The pupil's response to the second question is based on what is perceived--the antennae appear to be "grabbing the food". The question, however, is thought provoking and requires a rational answer. The pupil is expected to relate what is seen with an understanding of the function of antennae. Nevertheless, the teacher does not pursue this question and she continues to solicit further descriptions of perceptions. Communication of observations prevails, with no opportunity given for thinking about the observations nor for evaluating the statements made, in this instance, about antennae.

Small student microscopes (750X magnification) were introduced at the fourth lesson. These were set up in the "lab" and prepared with slides of the shrimp prior to the pupils' entry. The children made their observations as they peered into

one microscope after the other. No explanation was given about the function of microscopes or the limitations of their use.

The message about science conveyed by the discourse continues to be sensationalist. The children are expected to describe what they see and make notes of their observations. For example:

Vincent: I can see some bumps. And I can see the tail.

T: Describe the tail. Describe what you see.

The following interaction is further evidence of how the teacher avoids explanations which might help the children clarify their ideas. Although the pupil is asked to "think" about what he sees, no opportunity is provided to advance the thinking skill to the point where the pupil is able to evaluate his statement. The teacher does not appear eager to challenge the pupils' ideas. The implication is that the children may come to an understanding, eventually. In this example, the teaching model focuses on one skill, communication, in a way which enhances the transmission of a sensationalist view about inquiry.

Matthew: Hey, I see something moving around the tail.

T: Really?

Matthew: I think it's babies.

T: Really? What makes you think so?

Matthew: Maybe those shrimp don't lay eggs.

T: What do you think of the tail? The end of the tail.

Discussion Lessons

Two of the lessons were carried out as question and answer sessions in the classroom with the pupils seated at their desks. They did not have samples of the shrimp to which they could refer

during the discussions.

The discourse reveals that the teacher's questions still require a recall of observations; however, there is evidence of the beginning of a via media view about scientific inquiry. For example, after numerous questions about the shrimps' swimming patterns and whether or not they bump into each other, all of which could be answered by recalling observations, the children begin to respond differently.

T: How do you think they eat, Kurt?

Kurt: By sucking the water and that brings the food in.

T: Makeba, what do you think?

Makeba: Well, they would feel food and, yeah they would suck the water too.

Matthew: Well, sort of swim around and sort of bring it to their mouths with their feelers.

T: OK. Jeremy?

Jeremy: Well, the food comes in the mouth and they let the water out their gills.

T: Do you think they have eyes?

In the above extract the teacher's question requires information about shrimp that cannot be answered as a result of the pupils' observations. The responses show that the children refer to knowledge about similar organisms (fish) and they relate this information to what they perceive and understand about the shrimp. Even though Matthew still refers to his own observation, the other pupils' explanations are rational and make sense to them.

Another extract reveals the same clues to the beginning of a via media view about science. Moreover, there is some evidence

of the creative talent (of the model) as the children share ideas and provide interesting explanations. These pupils' comments follow the teacher's question about whether the shrimp observed are male or female.

Sam: Females have longer tails.

T: Why do you think the females will have longer tails?

Sam: I read about it.

Judith: I don't think we'll be able to see that.

Kurt: The female has longer tails just like Sam said so it can lay more eggs.

Makeba: Well, I think we can't tell because sometimes their tails grow to a certain size, just like us. Sometimes females are smaller than males.

Matthew: I agree with her in one way, but I don't think usually that's a factor. I don't think the tails are attractive.

The teacher's "why" question is critical and requires a rational response. The pupils do present logical answers and different points of view based on "other" knowledge and experience they may have, an example of the beginning of a via media view. Nevertheless, in this as well as in the previous extract, the teacher does not confirm any of the pupils' ideas. She accepts all the explanations as given and, by the end of the episode, the pupils are left with various possibilities about how the shrimp feed and how to identify the sex of the organisms. Although the discourse does convey the <u>beginning</u> of a via media view, the sensationalist message is still evident.

It is in these discussion lessons that new inquiry skills of the Taylor model become more evident. The focus is still on communication but there is evidence of divergent thinking and

decision-making skills. In these lessons, then, the teaching model appears to support the transmission of at least the beginning of a rational view of science inquiry.

The Interviews

The interview with the teacher confirmed the importance given to application of the Calvin Taylor teaching model. The teacher believed she had implemented all the inquiry skills of the model. While she wanted the children "to observe and notice any difference and come to a logical conclusion," she stated that forecasting and thinking skills had been stressed during a prior lesson which had not been recorded for the study. These skills, however, were not evident in the lessons which were observed and analyzed. The teacher also indicated that she normally does not like to challenge the children's theories. Rather, she prefers to wait for the them to derive their own logical answers since "they are smart enough to get it." In the lessons, this lack of challenge was evident by the way the teacher accepted the various ideas presented by the children (regarding the antennae, feeding, sex of the shrimp) without discussion or question. The manner in which the teaching model was applied, then, supported the transmittal of sensationalist ideas about inquiry.

Notwithstanding this teaching strategy, the teacher did express ideas about inquiry which modestly support a via media view--the need for pupils to analyze, to predict, to evaluate their actions and their ideas. She also acknowledged having a limited understanding of science which forced her to rely on the teacher's manual. In fact, the science lessons were the vehicle for application of the model. This suggests that the views about

scientific inquiry were being conveyed because of the pedagogy applied rather than because of an understanding of the different conceptions of scientific inquiry. The teacher was really unaware of which view about science was being transmitted during the lessons.

The interview with eight children confirmed that a discussion about the shrimp eggs and the brine solution had taken place during an initial lesson. Since they were very young, much of that discussion could not be remembered clearly. The children also indicated that they have access to science materials and books at home and, when necessary, a parent or relative is called upon to work with them or answer their questions. This could account for the way in which some of the children, during the discussions, were able to draw on information not evident from their observations and to show rational and reflexive thinking.

Conclusion

The results of this study reveal that analysis of science lesson interactions can provide useful information about science teaching practice in classes for gifted children. Prior to the lesson analyses, it was assumed that the 23 gifted children, with their advanced intellectual ability, would be exposed to the beginning of a rational via media view of scientific inquiry which depends on the relationships made between knowledge and experience. Moreover, application of the Calvin Taylor Multiple Talent Approach, with its focus on higher level inquiry skills, would facilitate the development of such a view. This was not borne out.

Application of the analytical scheme to the lesson discourse

revealed that the children were most often presented with a view of science based on random inquiry and sensory experience without benefit of existing knowledge--a sensationalist view. Also, incomplete implementation of the teaching model strengthened the transmission of this view.

The interview with the teacher revealed that she had little science knowledge and no understanding about the various conceptions about science which may be conveyed to children during ordinary science activities. Consequently, she could not recognize the close relationship between the inquiry skills of the pedagogical model she used and the science inquiry planned for the children. It is possible that her discomfort with science affected her application of the teaching model and thus the development of other inquiry skills of the model and of science.

Information derived from this study cannot be generalized--the data is too brief and the population too small; nevertheless, the results have certain implications for training master teachers for gifted classes and for development of science curricula. First, training teachers to apply different strategies or models should not be an end in itself. Focus on pedagogy should not overlook the philosophy of the subject being taught, in this case, science. Teachers should realize that the manner in which teaching strategies are implemented affect the messages about science conveyed to pupils. This, of course, requires teachers of gifted children to have a better than average, if not extensive, understanding of science in order to facilitate the application or adaptation of a teaching model to

science inquiry. Second, science teaching, generally, is in a critical state in Canadian and American schools where the basic subjects have taken over the curriculum in all classes. Gifted children, however, often enter the fields of mathematics and science to become our future scientists. Then, the science knowledge and understanding they acquire in the early school years is the base on which their adult understanding is built. Every effort should be made to include extensive science inquiry lessons in all regular or enrichment classes for these children.

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APPENDIX

Sensationalist Ideas About Science

Elementary science lesson discourse conveys sensationalist ideas about science, if one or more of the following clues are revealed:

Ideas About Observation	Ideas About Experiment	Ideas About Explanation
T solicits, accepts as much sense-data information as possible without telling Ps what to look at or what to look for.	T solicits, Ps freely gather as much sensory data as possible from various tests.	T's questions may use "why", "explain", or "how do you know" in same context as describe. Requires information derived from Ps' own experiences.
Ps are preoccupied with random observations. They perceive what is concrete and obvious through the use of their senses.	Ps carry out experiments in a random manner without T direction as to procedure or results to expect.	Ps answer or explain with sense-data descriptions of what is (or was) concrete and has been experienced.
T does not provide scientific information about material being observed. T expects that observations may generate an understanding about the material being examined.	T does not provide scientific information about problem being investigated. T expects that investigation and results may generate new understandings.	T does not provide scientific information in explaining events experienced.
T and Ps talk about observations using descriptive non-scientific language.	T and Ps talk about investigations and results using descriptive, non-scientific language.	T and Ps explain events using descriptive, non-scientific language.

Figure 1. Analytical Scheme. Three categories for the identification of sensationalist ideas about science.

Formalist Ideas About Science

Elementary science lesson discourse conveys formalist ideas about science, if one or more of the following clues are revealed:

Ideas About Observation	Ideas About Experiment	Ideas About Explanation
T directs Ps so that certain information is perceived which fits the T's expectations and knowledge.	T directs Ps' experiments so that they are carried out in a particular way, according to the T's understanding of the problem.	T directs questions or requests explanations so that acceptable information is provided which T expects and knows.
Ps' observations are limited to and confirm expectations, irrespective of their own perceptions and experiences.	Experiments are successful if data gathered by Ps confirm T's expectations and preconceptions.	Ps' explanations limited to science information (rules) given. Not related to their own experiences. Confirm T's expectations.
Ps' observations may be altered to confirm what is known and expected.	Ps may talk about changing results or repeating an experiment if results contradict expectations.	T's explanations include science information (rules, definitions) derived from T's knowledge, irrespective of Ps' understanding and experience.
T and Ps may use, scientific vocabulary when referring to observations with no evidence of a link between the terms used and Ps' perceptions.	T and Ps may use scientific vocabulary when referring to procedures or results. Ps may not understand meaning of terms in context of investigation.	T and Ps may use, scientific vocabulary with no evidence of a link between terms used and Ps' understanding of terms in context of explanation.

Figure 2. Analytical Scheme. Three categories for the identification of formalist ideas about science.

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Via Media Ideas About Science

Elementary science lesson discourse is developing via media ideas about science, if one or more of the following clues are revealed as 'forerunners:

Ideas About Observation	Ideas About Experiment	Ideas About Explanation
T provides "set" or framework for Ps' observations so that certain features are recognized and others ignored.	T provides "set" or framework for Ps' experiment so that aimless activity is prevented.	T's questions require rational response based on science information and Ps' experiences.
Ps talk about certain observations as more relevant than others because of their understanding and experience.	Ps and T talk about experiment by referring to Ps' prior experience and understanding of context in which investigation is carried out.	Ps make sense out of new problem by drawing on information acquired from T or other sources and their own experiences with same or similar events.
T and Ps link perceptions to what is known or understood about material and to Ps' own experience with same or similar material.	T does not indicate what results to expect, but Ps directed to relevant aspects of investigation.	T's explanations relate known science information with Ps' understanding and experience.
T and Ps use complex, scientific vocabulary when talking about observations. Ps understand meaning of terms and context in which used.	T and Ps use complex, scientific vocabulary when talking about results or experiments. Ps understand meaning of terms and context in which used.	T and Ps use complex, scientific vocabulary to explain events. Ps understand context in which used.

Figure 3. Analytical Scheme. Three categories of forerunners to the identification of via media ideas about science.

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